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Beyond Startup Creation: Tempered Intentions and Self-Efficacy Gains Among Graduate Student Researchers in Entrepreneurship Education

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Abstract

This paper reports on findings from a multi-cohort, multi-year evaluation of a semester-long technology commercialization course designed for graduate student researchers at a large research university. Aggregate pre- and post-course survey data were collected from 324 and 209 students, respectively, over a 12-year period. Participants included master's and doctoral students primarily from science and engineering disciplines. Results show substantial increases in entrepreneurial self-efficacy across venture development tasks, along with gains in perceived entrepreneurial competence and comfort with uncertainty. At the same time, short-term entrepreneurial intentions became more tempered following course participation, while long-term aspirations remained strong. This pattern suggests that exposure to the complexities of technology commercialization may prompt a more realistic appraisal of near-term venture creation without diminishing longer-term interest. Because surveys were not matched at the individual level, findings reflect cohort-level patterns. Results support evaluating academic entrepreneurship programs using broader capacity-building metrics beyond startup creation.

Introduction

Universities are placing a growing emphasis on preparing graduate students to translate scientific discoveries into real-world applications. This is particularly prevalent at research institutions, where there has been a push to create more “entrepreneurial universities” capable of commercializing technology arising from significant public investments in academic research. Desired outcomes for universities include contributions to economic development, new revenue streams, and the development of human capital needed by contemporary economies and societies.

Exposing graduate student researchers to entrepreneurship education and training is one aspect of this trend. Courses and workshops tailored to graduate students’ needs and interests focus on fostering the mindset, skills, and confidence needed to pursue innovation and venture creation. Prior research shows that entrepreneurship education can positively influence entrepreneurial intention and self-efficacy, particularly among STEM students [1], [2]. Meta-analyses further confirm positive links between entrepreneurship education and intention [3], and highlight the importance of skill-building outcomes [4]. However, much of the entrepreneurship education literature focuses on undergraduate populations, often using short-term interventions or single-cohort designs. Fewer studies have examined graduate student researchers, whose professional norms and career timing considerations may shape entrepreneurial intentions differently.

This paper summarizes findings from a multi-year evaluation of a semester-long technology commercialization and research translation course offered annually at a large research university. The course enrolls a self-selected population of master’s and doctoral students primarily from engineering, science, and technology-related disciplines. Using aggregated pre- and post-course

evaluation surveys collected at the beginning and end of the semester, this study examines patterns in entrepreneurial intentions, entrepreneurial self-efficacy, and perceived venture-related competencies. The research questions are the following:

- How do students' short-term and long-term entrepreneurial intentions shift after completing the course?
- To what extent does course participation impact entrepreneurial self-efficacy across venture development tasks?
- How do participants rate their overall entrepreneurial ability and risk tolerance after completing the course?

Literature Review

Academic Entrepreneurship and Graduate Student Training

Research universities are considered critical sources of technological innovation. Supported by technology transfer offices (TTOs) and entrepreneurship centers, contemporary universities are expected to move research findings and expertise from labs to companies through startups, or by licensing innovative technologies and solutions to existing companies. These market-facing activities highlight the changing role of the university over time, from one focused primarily on teaching and research to one that engages with the economy and society through knowledge and technology transfer, industry engagement, and entrepreneurship. Today, research institutions, in particular, are expected to play an active role in regional and national economic development, fulfill a broader societal responsibility beyond traditional academic activities, and strengthen the university-industry ties necessary to sustain and grow research funding [8], [9].

In addition to patent filings and startup formation, university entrepreneurship initiatives increasingly emphasize the development of innovation competencies among graduate students, particularly those in STEM fields. Education is considered a key method for motivating and equipping them with the knowledge and skills necessary to navigate technology translation and commercialization activities [5], [10], [11]. Given trends in the academic job market, it also has the added benefit of preparing them for a wider range of professional careers and work contexts. Data suggest that an increasing number of PhD recipients in science and engineering fields obtain jobs outside academia [12]. Research examining how entrepreneurship training influences graduate students' self-efficacy and career orientation remains very limited compared with the extensive undergraduate literature on the topic.

Most entrepreneurship education for graduate students is highly experiential, focusing on activities such as conducting market research, developing business models, and creating pitches for their own discoveries [13]. Evidence from the National Science Foundation I-Corps program, a national initiative focused on technology commercialization, suggests that entrepreneurship training has many benefits beyond startup creation, including providing market feedback that enables researchers to shift their research focus in a more market-facing direction and enabling them to integrate entrepreneurship concepts into their teaching and training [14].

Nevertheless, several barriers exist to getting graduate students to participate in technology commercialization and entrepreneurship training. First, some have a strong "taste for science"

and little interest in learning about business or entrepreneurship [9]. Second, many feel they cannot participate due to a lack of time, research priorities, advisor expectations, department culture, or personal commitments [15]. Third, there is ongoing skepticism about whether entrepreneurship education creates "more or better entrepreneurs" [4], p. 211. Nevertheless, scholarship supports the view that there are significant benefits to developing distinct entrepreneurship competencies that go beyond venture creation.

Human Capital Theory and Entrepreneurial Self-Efficacy

Human capital theory posits that skills, knowledge, and abilities acquired through education, training, work experiences, and other investments in oneself are forms of capital that can improve individual productivity and economic outcomes [16], [17]. Investments in human capital are expected to return individual and economic returns, such as higher earnings and better job performance over time, because they expand an individual's ability to perform value-generating tasks.

Applied to entrepreneurship, human capital theory suggests that investments in education, experience, and skill development increase the likelihood of successful entrepreneurial engagement. Research indicates that entrepreneurship-specific knowledge and skills are more strongly associated with entrepreneurial performance than general education alone [18], [19]. In technology-based entrepreneurship contexts, both technical and market-oriented human capital are critical. Wright et al. highlighted the importance of advanced scientific and engineering knowledge, commercialization capabilities, and team-based skills for technology-based entrepreneurship [20]. The authors position students and researchers as early-stage human capital investors who accumulate skills that may later support entrepreneurial careers, even if ventures fail in the short term.

Another developmental precursor to entrepreneurial action is self-efficacy. Self-efficacy is defined as an individual's belief in their capacity to organize and execute the actions required to produce desired outcomes in specific situations. Self-efficacy is not a measure of actual skills but rather a judgment of one's ability to apply skills successfully in various circumstances ([21]. Bandura's framework is part of Social Cognitive Theory (SCT), which holds that interactions among personal factors, behavior, and environmental influences shape human behavior. Central to SCT is that people regulate their actions based on beliefs about their own self-efficacy.

Entrepreneurial self-efficacy (ESE) refers to its application within the domain of entrepreneurship. In other words, ESE relates to an individual's confidence in their ability to perform the diverse tasks and challenges associated with entrepreneurial activity. ESE is associated with the formation of entrepreneurial intentions, persistence in goal pursuit, opportunity recognition, and venture performance [22], [23].

Career Stages and Timing Considerations

A growing body of research suggests that entrepreneurial engagement among academic scientists and engineers is influenced by career stage and professional timing. Pressure to publish, secure funding, and complete degree requirements may moderate near-term entrepreneurial intentions

even when long-term interest remains strong [9], [24]. Traditional doctoral training programs emphasize research productivity, while entrepreneurial activities are often framed as supplemental or extracurricular. Consequently, students may have a long-term interest in entrepreneurship but moderate near-term intentions due to resource constraints, as well as advisor and career expectations.

Practical considerations, such as the availability of time, are also a barrier. Commercialization of early-stage technologies typically involves additional research, prototype refinement, market assessment, intellectual property protection, regulatory approval, and team formation, all of which can extend well beyond the duration of a typical master's or PhD program. These activities can divert considerable time from a graduate student's program completion, imposing significant opportunity costs. From this perspective, entrepreneurship training may serve as a capacity-building platform, with returns that materialize only after additional experiences and resources are acquired [16].

Graduate students engaged in entrepreneurial activity may also experience role strain as they balance expectations as research trainees with emerging entrepreneurial interests. Role strain theory suggests that competing role demands can constrain participation across domains (Goode, 1960). Empirical studies indicate that students often perceive entrepreneurial engagement as detracting from research productivity and potentially extending time to degree completion (Hayter et al., 2017; Roach & Sauermann, 2010). Institutional norms and incentive structures within academia may therefore moderate near-term engagement in entrepreneurial activity even when interest and confidence increase.

Taken together, human capital theory and social cognitive theory suggest that entrepreneurship education may increase graduate students' innovation-related competencies and entrepreneurial self-efficacy. At the same time, institutional norms and career-stage considerations may shape how these developmental gains translate into short-term versus long-term entrepreneurial intentions. However, limited longitudinal evidence has examined these dynamics among graduate students in research-intensive academic programs. The following summary of evaluation data addresses this gap by examining aggregate patterns in intentions and self-efficacy among STEM graduate students participating in a semester-long entrepreneurship course.

Methods

The course we examine in this study is called Technology Entrepreneurship and Research Translation. The course description and the learning objectives are as follows:

> "The course introduces graduate students and academic researchers to the intellectual, leadership, financial, and management processes for translating research and innovation into tangible products. Topics include tools and resources for market research, financial analysis, intellectual property, venture development, and entrepreneurship for early-stage commercialization activities both within and outside of academia. Key factors are illustrated through case studies in various academic disciplines and industry sectors. At the end of this course, students will be able to: 1) Describe the process required to translate research into commercial ventures; 2)

> Employ frameworks for evaluating and developing research for commercialization; 3) Critically analyze whether to participate in commercialization activities, how best to participate, what to expect as outcomes, and how to position research to keep options open for future translation; 4) Enhance their professional development through understanding the business context for research and technological innovation."

Data Collection

To evaluate course-related outcomes, each year graduate students are invited to complete electronic pre-course and post-course surveys during the first and last weeks of the 16-week, semester-long course. Surveys are administered as part of routine instructional evaluation processes. Data were analyzed retrospectively in aggregate form for scholarly dissemination.

Sample

A total of 324 students completed the pre-course survey, and 209 students completed the post-course survey across course offerings from 2012 to 2024. Participants were graduate students enrolled in science, engineering, and related technology-focused degree programs. Survey participation was voluntary, and responses were not matched at the individual level to preserve anonymity. Because surveys were not linked across time points, analyses reflect comparisons of aggregate cohort-level distributions rather than within-subject change. This design limits causal inference but is consistent with multi-year instructional evaluation practices in which end-of-term survey response rates vary. Anonymity was maintained to encourage candid feedback.

Measures

This paper reports on survey items related to entrepreneurial intention, entrepreneurial self-efficacy, perceived entrepreneurial competence, and risk tolerance. Most items were measured using Likert-type scales (e.g., 1 = strongly disagree to 5 = strongly agree). Entrepreneurial self-efficacy was assessed using select items from the Venturing and Technology Self-Efficacy (VTSE) scale developed by Lucas and Cooper (2009). The VTSE assesses confidence in performing tasks such as opportunity evaluation, market assessment, and venture development activities. Consistent with social cognitive theory, items capture perceived capability rather than general attitudes toward entrepreneurship. Responses were measured on a 0–10 scale (0 = no confidence, 10 = complete confidence). Four primary items serve as the focus of our analyses.

Additional items were developed internally to align with the course's learning objectives and with commonly assessed constructs in entrepreneurship education research. Because the surveys were originally designed for instructional evaluation rather than experimental research, not all items correspond to validated multi-item scales. Accordingly, the findings are interpreted as indicative of perceived change rather than as precise psychometric estimates.

Analysis

Descriptive statistics were calculated for survey items at pre-course and post-course time points. Given the unmatched survey design, analyses focus on aggregate shifts across cohorts rather than

within-subject change. Results are presented as observed differences in mean responses and response distributions across time points.

Results

Findings are organized around the three research questions, focusing on observed differences in entrepreneurial intention, self-efficacy, and perceived competencies between pre-course and post-course survey responses.

Research Question 1: Shifts in Entrepreneurial Intention After Course Completion

Students were asked about their interest in starting ventures at three time points: while at the university, within 5 years, and within 5 or more years (Table 1). Overall, respondents reported moderate to high interest in entrepreneurial activities both before and after the course, with the strongest interest consistently observed for starting a venture in five or more years. In the pre-survey, a majority of students indicated they were very interested in starting a venture within the next five years (51.5%) or in five or more years (64.8%), while interest in starting a venture while a student was more moderate, with 41.7% somewhat interested and 30.9% very interested. Post-survey responses indicate a shift from "very interested" to "somewhat interested" across several items, reflecting a moderation of near-term entrepreneurial intentions. For example, the proportion of students reporting being very interested in starting a venture within the next five years declined from 51.5% to 38.3%, while those somewhat interested increased from 30.9% to 42.1%. Interest in starting a venture in five or more years remained high post-survey (59.3% very interested), indicating that long-term entrepreneurial aspirations remained high in post-course responses, even as immediate or near-term intentions appeared more moderated.

Table 1. Responses to the question: "To what degree are you interested in the following?"

	Pre survey		Post survey	
	n	**pct**	**n**	**pct**
Starting a venture while at [our university]				
Not at all interested	24	7.41	22	10.53
Not very interested	65	20.06	41	19.62
Somewhat interested	135	41.67	93	44.50
Very interested	100	30.86	53	25.36
Starting a venture of your own within the next five years				
Not at all interested	9	2.78	11	5.26
Not very interested	48	14.81	30	14.35
Somewhat interested	100	30.86	88	42.11
Very interested	167	51.54	80	38.28
Starting a venture of your own in 5 + years				
Not at all interested	6	1.85	4	1.91
Not very interested	15	4.63	14	6.70
Somewhat interested	93	28.70	67	32.06
Very interested	210	64.81	124	59.33

We also asked graduate students about their interest in participating in innovation and entrepreneurial competitions. This was to gauge another level of active involvement in entrepreneurial activities. A similar pattern was observed, with "very interested" decreasing from 38.0% to 33.0% and "somewhat interested" increasing from 37.0% to 42.6% (Table 2).

Table 2. Level of interest in participating in innovation and entrepreneurial competitions.

	Pre survey		Post survey	
	n	**pct**	**n**	**pct**
Participating in innovation or entrepreneurial competitions				
Not at all interested	12	3.7	11	5.26
Not very interested	69	21.3	40	19.14
Somewhat interested	120	37.04	89	42.58
Very interested	123	37.96	69	33.01

Research Question 2: Shifts in Entrepreneurial Self-Efficacy at Course Completion

Students responded to survey items assessing entrepreneurial self-efficacy using selected items from the VTSE. Participants rated their confidence on a 0–10 scale (0 = no confidence, 10 = complete confidence) (Table 3).

Table 3. Graduate Student Pre- and Post-Course Self-Efficacy Ratings.

	Pre				Post			
	mean	sd	median	IQR	mean	sd	median	IQR
Know the steps needed to place financial value on a new business venture	2.69	2.26	2	3	6.5	1.97	7	3
Pick the right marketing approach for the introduction of a new service	3.37	2.47	3	4	6.8	2.05	7	2
Recognize when an idea is good enough to support a major business venture	4.3	2.46	4	4	7.12	2.04	7	3
Recruit the right employees for a new project or venture	4.19	2.54	4	4	6.95	2.21	7	3

Post-course responses reflected higher mean confidence ratings across venture development competencies. The largest increase was observed in confidence in placing a financial value on a new venture, with mean pre-survey scores rising from 2.69 to 6.50 post-survey, representing a gain of 3.81 points. Confidence in selecting an appropriate marketing approach for introducing a new service also increased, from a mean of 3.37 to 6.80, a gain of 3.43 points. Confidence in recognizing when an idea is strong enough to support a major business venture increased from

4.30 to 7.12, reflecting a gain of 2.82 points. Finally, confidence in recruiting appropriate employees for a new project or venture also increased substantially, increasing from a mean of 4.19 to 6.95, a gain of 2.76 points. Across all four items, medians shifted from 2–4 in pre-course responses to 7 in post-course responses, indicating meaningful improvements in entrepreneurial self-efficacy related to early-stage venture evaluation, market strategy, and team formation.

Research Question 3: Perceptions of Overall Entrepreneurial Ability and Risk Tolerance at Course Completion

Students were asked about their perceived overall entrepreneurial ability at the start and the end of the course. They were also asked about their ability to deal with uncertainty. Given the strong association between risk and entrepreneurship, we wanted to investigate whether education and knowledge could reduce perceptions of risk.

Participants' overall self-assessment of their entrepreneurial ability was substantially higher in post-course responses compared to pre-course responses (Table 4). Before the course, nearly four-fifths of respondents rated their entrepreneurial ability as poor or fair (79.2%), with only 20.9% rating it as good or excellent. Post-survey, this pattern reversed, with a strong majority rating their ability as good or excellent (65.9%), while only 34.1% rated it as poor or fair. In particular, the proportion rating their ability as good increased from 19.3% to 58.1%, and those selecting excellent increased from 1.5% to 7.8%, indicating a substantial shift toward higher perceived entrepreneurial competence following course participation.

Respondents also reported improvements in their ability to deal with uncertainty from pre- to post-survey. At baseline, most participants rated themselves as good or excellent (64.7%), while 35.3% rated themselves as poor or fair. Post-survey, the proportion rating their ability as good or excellent increased to 79.5%, while those rating it as poor or fair declined to 20.5%. Interestingly, ratings of excellent increased from 15.0% to 25.4%, and ratings of fair decreased from 30.1% to 17.6%. This pattern suggests that, in addition to gains in specific entrepreneurial skills, participants also developed greater self-reported comfort with ambiguity and risk, which are central competencies associated with entrepreneurship.

Table 4. Observed Shifts in Perceptions of Entrepreneurial Ability and Risk Tolerance.

		Pre survey		Post survey	
		n	pct	n	pct
Overall, how would you rate your entrepreneurial ability.	Poor	112	34.36	2	0.98
	Fair	146	44.79	68	33.17
	Good	63	19.33	119	58.05
	Excellent	5	1.53	16	7.80
Overall, how would you rate your ability to deal with uncertainty?	Poor	17	5.21	6	2.93
	Fair	98	30.06	36	17.56
	Good	162	49.69	111	54.15
	Excellent	49	15.03	52	25.37

Discussion

Overall, our findings indicate that graduate students reported higher levels of entrepreneurial knowledge, self-efficacy, and perceived entrepreneurial competence in post-course responses, along with more nuanced shifts in intentions to pursue venture creation in the present and future. Participants reported substantial increases in confidence across several skills directly related to technology entrepreneurship—competencies that are often underdeveloped in traditional graduate and postdoctoral training.

Shifts in entrepreneurial intentions were more modest and, in some cases, moved from "very interested" to "somewhat interested," particularly for near-term venture creation and participation in competitions. Rather than reflecting diminished interest, this pattern may indicate that course participation prompted a more realistic appraisal of the time, resources, and risks associated with technology commercialization. Such exposure may temper near-term intentions without extinguishing them, or may discourage some students from near-term pursuit altogether. Disentangling these interpretations would require individual-level longitudinal data not available in this study. Regardless, long-term aspirations remained strong, with sustained interest in starting ventures in five or more years. Together, these patterns suggest that students may be integrating entrepreneurship into their career trajectories in ways that are compatible with the academic norms and expectations characteristic of this stage of professional development.

The observed increases in entrepreneurial self-efficacy align with human capital theory and social cognitive perspectives. The course provides structured exposure to market research, financial analysis, intellectual property considerations, and venture development processes. As students gain familiarity with these commercialization activities, their confidence in performing them appears to increase. Importantly, the strengthening of self-efficacy occurred even as short-term entrepreneurial intentions became more moderated, reinforcing the distinction between capability development and immediate venture action.

Self-assessments of overall entrepreneurial ability further reinforce this interpretation. Participants' ratings shifted substantially from poor or fair to good or excellent in post-course responses, suggesting that gains in specific knowledge and skills translated into broader perceptions of entrepreneurial competence. Similarly, reported ability to deal with uncertainty increased, with notable growth in "excellent" ratings. Given that uncertainty and ambiguity are central features of entrepreneurship-related work, these shifts suggest that students felt better prepared to navigate complex, evolving professional environments after taking the course.

Taken together, these results support the conclusion that entrepreneurship and commercialization training can strengthen graduate students' entrepreneurial human capital and self-efficacy, even if immediate venture formation intentions do not increase in parallel. From a programmatic and policy perspective, these findings support evaluating academic entrepreneurship initiatives using a broader range of outcomes—including skill development, confidence, and long-term orientation—rather than relying solely on short-term startup metrics. In research-intensive environments, where career trajectories often unfold over extended periods, such capacity-building outcomes may serve as meaningful precursors to later entrepreneurial engagement.

There are several limitations associated with this work. First, the unmatched survey design means that differences observed between pre- and post-course respondents may reflect variation in response patterns across time points rather than individual-level change, and causal inference is therefore not possible. Second, because participation was voluntary, selection bias cannot be ruled out. Third, the analysis relies on descriptive statistics, so observed differences should be interpreted as patterns of interest rather than statistically confirmed effects. Fourth, the analysis focused only on aggregate patterns across yearly course offerings, rather than examining year-specific effects, limiting the ability to detect whether outcomes shifted meaningfully over time. Finally, the data span more than a decade, during which broader changes in society, the economy, the job market, and entrepreneurship ecosystems may have influenced results in ways that are difficult to isolate.

Despite these limitations, the consistency of observed patterns across constructs suggests that technology commercialization and entrepreneurship training can meaningfully enhance innovation-related confidence among graduate students. The gains in competence and confidence observed in a once-per-week course are unlikely to detract significantly from scientific work or disciplinary identity. Rather, the findings suggest a complementary relationship in which entrepreneurial training can enhance scientists' and engineers' capacity to translate research into societal impact while maintaining a strong research identity.

Conclusion

This multi-year evaluation indicates that graduate-level commercialization training is associated with higher entrepreneurial self-efficacy, perceived competence, and sustained long-term entrepreneurial interest among STEM graduate students. Although short-term venture intentions became more moderated in post-course responses, long-term aspirations remained strong, suggesting the appropriate integration of entrepreneurship into future career plans. These findings support evaluating graduate entrepreneurship initiatives using broader capacity-building indicators rather than relying solely on immediate startup outcomes.

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